MOISTURE DETECTION SENSORS FOR BUILDING STRUCTURES

FIELD OF THE INVENTION

The present invention relates to the detection of water penetration into residential and commercial buildings.

BACKGROUND

Water intrusion into buildings is a massive and growing problem. Leaking buildings cost homeowners, commercial property owners and property insurers hundreds of millions of dollars every year. Even the smallest leaks that channel water into building walls can cause expensive problems. Structural damage to plywood sheathing and stud walls due to wood rot has been commonplace for decades. Black mold or toxic mold that grows in the wet walls is known to cause severe physical problems for occupants as well as severe fiscal problems for builders and insurance companies.

Early detection and location of building envelope penetration will allow the builder or owner to identify developing problems and carry out minor repairs. Homeowners, builders, and insurance companies can avoid high costs resulting from extensive structural damage, health problems, insurance claims and potential lawsuits.

Several water detection sensors are commercially available. Moisture detection tapes, spot sensors and cables of various designs are known. The available sensors are designed for use on floors and plumbing fixtures, or to be wrapped around pipes. One form of detection tape, with flat, exposed conductors is designed for open use and is not suitable for direct placement within a building structure where metallic building elements could cause a short across the exposed sensing elements. A tape of this type is disclosed in United States patent 6,175,310. None of the currently available sensors is suited for

placement within a building structure next to the protective moisture barrier that is often referred to as the building envelope.

An even greater problem that the prior art does not address is the potential for wood elements to absorb moisture to the point of saturation without being detected. Plywood or OSB sheathing and lumber studs, joists, beams and rafters can easily absorb a slow leak of water through the building envelope. The ingress of water can be at a sufficiently low rate that the hygroscopic properties of wood allow total absorption without a detectable amount on the surface to dampen and create a conductive path between the sensing conductors. The present invention addresses these shortcomings and provides a novel and effective moisture detection system.

SUMMARY

According to one aspect of the present invention there is provided a moisture detection sensor comprising:

a substrate of dielectric, hydrophobic material;

two elongate, parallel, conductors secured to a top surface of the substrate;

a protective layer of non-hygroscopic, water pervious material secured to the to surface of the substrate and extending over the conductors; and

a mounting adhesive on a bottom surface of the substrate.

The preferred sensor is an elongate tape suitable for placement within a building structure, adjacent the building envelope. The moisture detection tape may be placed in areas prone to water ingress to detect the first trace of moisture penetration. The detection tape conductors are connected to the input leads of a remote sensor unit which, when triggered by the detection tape, transmits coded alarm signals.

The tape is of laminated construction with the preferred configuration having a substrate of rugged, high-dielectric strength and two flat copper conductors adhered to the dielectric substrate. The high-dielectric strength substrate provides mechanical strength and electrical insulation from the surface it is applied to. The substrate is coated with a pressure sensitive mounting adhesive that provides good adhesion to standard building materials such as wood, wood laminates, concrete, steel, galvanized steel, PVC, ceramic, etc. The adhesive backing is desirably non-water soluble and selected to provide good adhesion characteristics over the anticipated application temperature range, e.g. -10°C to +50°C. The adhesive backing is protected prior to installation by a peel-off release layer. The protective non-hygroscopic dielectric layer over the conductors provides mechanical and insulating properties such that contact with metal surfaces does not cause a short circuit across the conductors while allowing water to penetrate to the conductor surfaces and bridge the gap between the conductors.

The conductors are preferably flat metal strips no less than 6.5 mm wide and spaced apart by a distance no less than 13 mm, preferably 13.6 mm. The width and spacing of the flat copper conductors are of importance in the preferred design. The conductor should be of sufficient width that a nail or screw of up to 4.8 mm in diameter, such is commonly used in construction, will not cut the conductor in two if inadvertently driven through the tape. The conductor spacing should be such that a misplaced construction staple of up to 12.7 mm wide cannot bridge the space between the conductors and cause a short circuit between the conductors.

A further moisture detection component may be incorporated to detect and measure moisture that has been absorbed directly into an underlying building component, for example an absorbent wood component. This can occur

without wetting the detection tape surface and would go undetected. To deal with this, the sensor includes at least two moisture probes adapted to penetrate the protective layer, the respective conductors and the substrate and to extend into a building component to which the substrate has been adhered, each probe being a conductive element of corrosion resistant material.

According to another aspect of the present invention there is provided a moisture detection sensor comprising:

an elongate tape;

two elongate, parallel, conductors secured to a top surface of the tape;

at least two moisture probes adapted to penetrate the tape and the respective conductors and to extend into a building component to which the tape has been attached, each probe being a conductive element of corrosion resistant material.

In use, a pair of the, non-corroding probes, appropriately calibrated, are inserted though the conductors into an structure of absorbent material, for example wood. This is especially useful at critical points, for example, the area below a window sill, the sheathing just above a floor plate, and the floor joists below an exterior door. The probes are intended to make intimate electrical contact with the detection conductors. The detection conductors then serve as conductors whereby electronic sensors connected to the end of the detection tape are electrically connected to the moisture probes.

According to a further aspect of the present invention, there is provided a method of detecting moisture in an absorbent material, the method comprising:

providing two conductors on or adjacent a surface of the material;

and

penetrating each conductor and the absorbent material with a conductive probe;

applying a voltage across the two conductors; and

monitoring currents passing between the conductors.

In a building structure, the absorbent material will normally be a wood component that may be wet internally, although there is insufficient moisture on the surface to trigger a surface mounted sensor, for example the tape alone. The internal moisture would, in the absence of the probes, go undetected, and might result in rotting of the wood structure.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings, which illustrate exemplary embodiments of the present invention:

Figure 1 is a top view of the flat conductors and substrate of a detection tape;

Figure 2 is an exploded sectional view along line II-II of Figure 1 showing the various layers of the detection tape;

Figure 3 is a graph of probe to probe resistance versus moisture content;

Figure 4 is an isometric view of a moisture probe;

Figure 5 is an end view of the probe; and

Figure 6 illustrates the connection of the detection tape to a sensor unit.

DETAILED DESCRIPTION

Referring to the accompanying drawings, and particularly Figures 1 and 2, there is illustrated a moisture detection tape 100. The tape is constructed by applying a non-water soluble adhesive (4) to a 40 mm wide x 0.1 mm thick

polyvinyl chloride substrate (3). Two 0.1 mm thick x 6.6 mm wide soft bare copper strips (1,2) are laid down on the adhesive coated substrate with a 13.6 mm edge-to-edge separation. A non-hygroscopic, non-woven, water pervious layer (5) is applied over the polyvinyl substrate (3) and the copper conductors (1,2). A non-water soluble adhesive layer (6) that will adhere to common building materials such as wood, steel, concrete, etc. is applied to the underside of the polyvinyl substrate (3). A 40mm wide x 0.1 mm thick peel off release layer (7) is applied over the underside adhesive layer (6).

Referring to Figure 6, when the tape is installed on a moisture absorbent building element, for example wood, moisture probes (9), (10) are inserted through the detection tape conductors at critical point-locations. The probes are constructed of stainless or copper-clad steel. Each of the probes (9) and (10) is of a dual prong design as illustrated in Figures 4 and 5 and is in the form of a conventional staple with a crown 90 and two legs or pins 91 as is well known. Such a staple can be inserted with a standard construction-stapling tool . Thus, as shown in Figure 6 each staple lies with its crown 90 extending along the respective conductor and both of the legs or pins 91 of the staple 9 engaging into first conductor 1 and both of the legs or pins 91 of the staple 10 engaging into second conductor 2.

The probes form a moisture level measurement system. The electrical resistance between the probes, which are inserted parallel to one another in the two flat conductors, varies in proportion to the moisture content in the wood material. By carefully selecting the probe dimensions, distance apart and depth of insertion, the measured resistance can be used to calculate the percent moisture content in the wood according to the relationship illustrated in the graph of FIGURE 3. This provides a noninvasive method to effectively and continuously monitor moisture levels. Unacceptably high moisture content levels,

that would otherwise go undetected with a surface moisture detection method, are readily detected.

Typically up to ten pairs of moisture probes may be inserted on a single section of detection tape including, as shown in Figure 6, a first pair 9, 10 of said up to ten pairs and a second pair 9A, 10A of said up to ten pairs. The parallel resistance of the probes can then be measured remotely by a pair of conductors that are spliced to the end of the detection tape.

The equivalent effective single probe resistance is then calculated by

$$R_{eff} = R_{meas.}/N \quad (1)$$

Where:

$R_{meas.}$ is the resultant measured resistance across the flat conductors

N is the number of probe pairs on a single tape run

From R_{eff}, the average moisture content can be calculated using:

$$M\% = 23.896\ R_{eff}^{-0.1451} \quad (2)$$

Where: M% is the average moisture content in the wood component

The moisture detection tape and probe system is then connected to a pair of insulated conductors (11) by means of insulation displacement connectors (12). The conductor pair is terminated on a pair of input terminals (13) of a sensor device (14) that measures the resistance of the moisture tape and probe combination.

While one embodiment of the present invention has been described in the foregoing, it is to be understood that other embodiments are possible within the scope of the appended claims.